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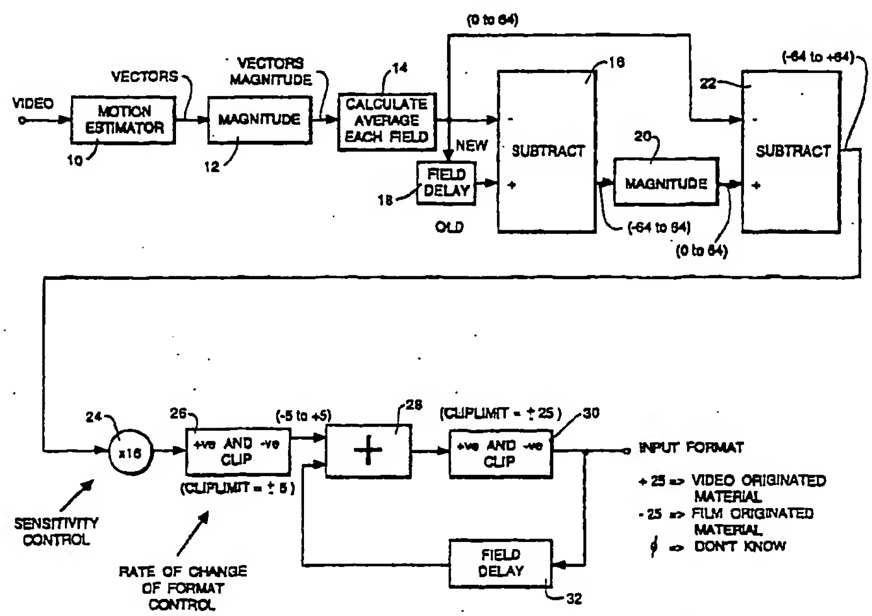

(57) Abstract

A method of distinguishing from "true" video, video material which was originated on film video or, more generally, detecting the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images, involves measuring a motion parameter such as a field averaged motion vector magnitude. A difference value is taken from successive motion parameters; this is subtracted from the motion parameter and the results of said comparison are accumulated. A trend of positive results is indicative of "true" video and a trend of zero or negative results suggests image repetition.

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VIDEO SIGNAL PROCESSING

This invention relates to video signal processing.

It is well known that a variety of video processes which are optimised for video material having a particular temporal sampling rate, can function differently – and usually less well – with video material transferred from film or converted in some other way from an original temporal sampling rate which was lower. If the origins of the video material which is to be processed are known, the process can be appropriately optimised at the outset. A difficulty arises where the origins of the material are unknown or where the video material is a compilation of material having different origins. Video material which originated from film (whether 24 Hz, 25 Hz or 30 Hz), slow motion replays and animation will usually have repeating images which will lead to sub-optimal performance in particular video processes, unless correctly identified.

It is an object of the present invention to provide a relatively straightforward yet reliable method of detecting, in a video signal having a particular temporal sampling rate, the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images.

Accordingly, the present invention consists in a method of detecting, in a video signal having a particular temporal sampling rate, the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images, comprising the steps of measuring a motion parameter between successive images, determining a difference value between successive measured motion parameters; comparing the motion parameter and difference values and accumulating the results of said comparison.

Preferably, the motion parameter comprises the average magnitude of the motion vectors.

Suitably, the results of the comparison are accumulated by monitoring a trend in the sign of the comparison.

This invention can operate using any of a wide variety of known techniques for splitting a picture into blocks and measuring a motion vector between these blocks in successive images. The average vector magnitude

is calculated from the motion vectors measured between every successive image. The magnitude of the temporal differential of the average vector magnitude is calculated and this number is subtracted from the average vector magnitude. It is to be expected that in "true" video material the temporal differential of the average vector magnitude will tend to be less than the average vector magnitude. The subtraction will therefore generally produce a positive result and by noting a trend of positive results, the material can be inferred as video originating.

In the case of material which was originated as film, the average vector magnitude will switch from a value which is representative of the picture content to an artificially low value (theoretically zero) where motion is measured between two fields which originate from the same film frame. With this variation, the differential of the average vector magnitude will be generally high compared to the average vector magnitude itself. Accordingly, subtracting the differential measurement from the actual measurement will produce a zero or negative result and a tendency towards negative results will enable detection of film originating material.

In converting from 24 Hz film to 60 Hz NTSC, it is usual to employ the well known 3:2 pulldown sequence. For subsequent video processing, it is desirable not only to detect the character of the film originating material but also to identify the precise phase in the field duplicating and reordering sequence that arises from the 3:2 pulldown process.

Apparatus which detects the phase of the 3:2 pulldown sequence already exists and reference is directed for example to WO/91 06182. Known approaches generally compare fields from successive video frames to derive a field difference signal which will be expected to be small in the case of duplicate fields added in the 3:2 pulldown. A logic arrangement is then provided to identify a repeating pattern in the sequence of field difference signals. It is an object of the present invention to provide an alternative method for identifying the phase of the field duplicating and reordering sequence in video material resulting from a 3:2 pulldown process.

Accordingly, the present invention consists, in a further aspect, in a

method for identifying the phase of the field duplicating and reordering sequence in video material resulting from a 3:2 pulldown process comprising the steps of measuring a motion parameter; storing a sequence of measured motion parameters for successive fields; comparing the pattern of motion parameters with known patterns associated respectively with different phases of the field duplicating and reordering sequence and selecting the phase providing the closest match.

The present invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a block diagram illustrating apparatus according to one aspect of the present invention, for distinguishing between video originated and film originated material;

Figure 2 is a block diagram illustrating apparatus according to a further aspect of this invention for identifying the phase of a 3:2 pulldown sequence and Figure 3 is a block diagram illustrating, in more detail, one component of the apparatus of Figure 2.

Referring initially to Figure 1, video material passes to a motion estimator 10 which generates motion vectors. The motion estimator can take a wide variety of known forms with a particularly suitable technique being that of phase correlation as disclosed, for example, in GB-B-2 188 510. The magnitude of the motion vectors derived by the motion estimator 10 is calculated in block 12 and these magnitudes are averaged for each field in block 14. The field-averaged vector magnitude, which can be regarded as a motion parameter for that field, is taken directly as one input to subtracter 16 and via a field delay 18 to form the other input of the subtracter. The output of the subtracter, which is then the difference in the motion parameter for successive fields, is then passed through block 20 which serves to extract the magnitude. A further subtracter 22 takes as its positive input, the current motion parameter and as its negative input the magnitude of the difference signal.

As has been previously noted, a tendency to positive results in the subtracter 22 will be indicative of video originating material whilst a tendency

towards negative results will be indicative of film originating material. The remainder of the circuit shown in Figure 1 is concerned with identifying these tendencies in a manner which is reliable, which responds in a proper manner to cuts between film originated and video originated material and which deals in a sensible manner with picture material having finite but unusually low movement.

Thus, the output of subtracter 22 passes through multiplier 24 performing a x 16 operation. As will be described subsequently, the choice of coefficient for the multiplier affords a degree of sensitivity control for process. The output of the multiplier 24 passes to block 26 which serves to clip the signal in both positive and negative senses. In this case, the clipping occurs at ± 5 although, as will be described, the choice of clip limits provides a measure of control over the rate at which apparent changes between video originated and film originated material are detected. The clip signal from block 26 is accumulated and further clipped in an arrangement which comprises an adder 28, a clipper 30 and a field delay 32. The output of clipper 26 passes through adder 28 to a further clipper 30 which has a clip limit of ± 25. The adder 28 receives as its second input the output of the clipper 30 passed through the field delay 32.

In the case of video originating material having constant motion, the differential vector magnitude will be zero and, with the gain afforded by multiplier 24, the output from clipper 26 will be continuously + 5. It will be seen that after 5 cycles, the output of the clipper 30 will reach and will be held at the positive clip limit of + 25. In the more normal case in which there is varying motion, the motion vector differential will be non-zero but nonetheless smaller on average than the actual motion vector magnitude. The sensitivity provided by multiplier 24 is selected so that in most cases, the output of clipper 26 remains at the positive clip limit so that a rate of change of 5 cycles, (from the zero condition) still applies. In the case of very small motion with, for example, "talking heads" picture material, the high gain of multiplier 24 ensures that information regarding the motion is still made use of. The clip limit in block 26 may not be reached and the rate of

change of the detector output will therefore be slow.

In the case of film originating material, the output from subtracter 22 will be expected to be zero or negative. In an analogous manner, the first clip limit of – 5 and the accumulated clip limit of – 25 will apply and an output of –25 can be identified with film originating material. It will be noted that an output of zero is taken simply to mean "don't know".

The five-fold relationship between the clip limits of block 26 and 30 have been selected to govern the delay after which the detector switches between video originating and film originating material in the "ideal" case of a cut between constant motion film and constant motion video. If a longer delay is appropriate, a ten-fold or greater differential between the two clip limits can be employed.

Turning now to Figures 2 and 3, there is shown a further embodiment of the present invention which is capable of identifying the phase of the 3:2 sequence in 60 Hz NTSC material originated on film and subjected to a 3:2 pulldown. Certain components are shared in common with the embodiment of Figure 1. These components have the same reference numerals and will not be described in any more detail.

The output from block 14, which is a motion parameter in the form of an average motion vector for the field, is taken to a chain of field delays 40–46 These feed in turn an array of match filters 50–58, clocked at field rate by means of a modulo 5 counter 60.

Referring now to Figure 3, there is shown in more detail the structure of each match filter 50–58. It will be seen that the input to the match filter is taken to a chain of field delays 70–76 which feed multipliers 80–88. The coefficients A to E supplied to these multipliers, vary in the clock cycle as follows:–

	A	B	C	D	E
0	+1	−1	+1	−1	−1
1	−1	+1	−1	+1	−1
2	−1	−1	+1	−1	+1
3	+1	−1	−1	+1	−1
4	−1	+1	+1	−1	+1

The output of the multipliers 80–88 are taken through adder 90 which generates the output for the match filter.

Returning to Figure 2, the outputs of the match filters are taken through respective recursive filters 100–108 which generate the five inputs for selector 110. The function of this selector is to pick the largest output from the recursive filters 100–108. In the ideal case, only one output will be positive. There is preferably hysteresis built into the selector 110 so that short term shifts in the ranking of the inputs, arising from noise, are ignored. The coefficient sequence of the selected match filter indicates the field sequence of the input video.

It should be understood that this invention has been described by way of example and a wide variety of modifications are possible without departing from the scope of the invention. Whilst the example has been taken of 3:2 pulldown, the method of the invention is capable of, more generally, detecting the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images.

CLAIMS

1. A method of detecting, in a video signal having a particular temporal sampling rate, the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images, comprising the steps of measuring a motion parameter between successive images, determining a difference value between successive measured motion parameters; comparing the motion parameter and difference values and accumulating the results of said comparison.

2. A method according to Claim 1, wherein the step of measuring a motion parameter between successive images comprises identifying a plurality of motion vectors associated with respective regions of the image and taking the average magnitude of the motion vectors.

3. A method according to Claim 1 or Claim 2, wherein the step of accumulating the results of said comparison comprises monitoring a trend in the sign of the comparison.

4. Apparatus for detecting, in a video signal having a particular temporal sampling rate, the residual effect of a past conversion from a lower temporal sampling rate involving the repetition of images, comprising means for measuring a motion parameter between successive images, means for determining a difference value between successive measured motion parameters; means for comparing the motion parameter and difference values and means for accumulating the results of said comparison.

5. Apparatus according to Claim 4, wherein the means for measuring a motion parameter between successive images serves to split a picture into blocks, to measure a motion vector between these blocks in successive images and to calculate an average vector magnitude from the motion vectors measured between each pair of successive images.

6. Apparatus according to Claim 5, wherein said means for comparing the motion parameter and difference values serves to subtract the magnitude of the temporal differential of the average vector magnitude from the average vector magnitude.

7. A method for identifying the phase of the field duplicating and reordering sequence in video material resulting from a 3:2 pulldown process, comprising the steps of measuring a motion parameter; storing a sequence of measured motion parameters for successive fields; comparing the pattern of motion parameters with known patterns associated respectively with different phases of the field duplicating and reordering sequence and selecting the phase providing the closest match.

8. A method according to Claim 7, wherein the step of measuring a motion parameter comprises identifying a plurality of motion vectors associated with respective regions of the image and taking the average magnitude of the motion vectors.

9. Apparatus for identifying the phase of the field duplicating and reordering sequence in video material resulting from a 3:2 pulldown process, comprising means for measuring a motion parameter; means for storing a sequence of measured motion parameters for successive fields; means for comparing the pattern of motion parameters with known patterns associated respectively with different phases of the field duplicating and reordering sequence and means selecting the phase providing the closest match.

10. Apparatus according to Claim 9, wherein said means for comparing the pattern of motion parameters with known patterns associated respectively with different phases of the field duplicating and reordering sequence comprises five match filters receiving said sequence of measured motion parameters delayed by one field interval from one match filter to the next.

Fig.1.

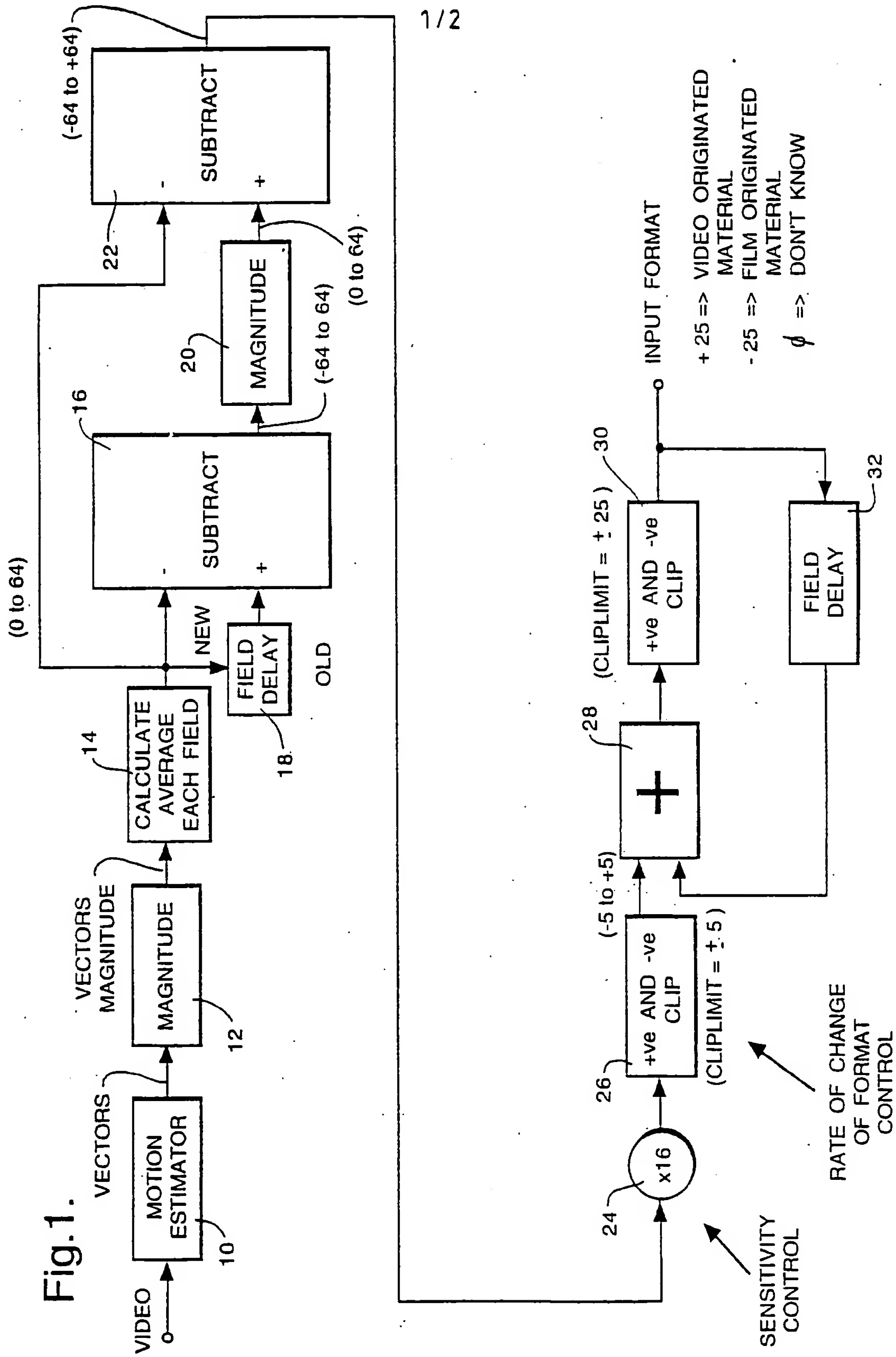
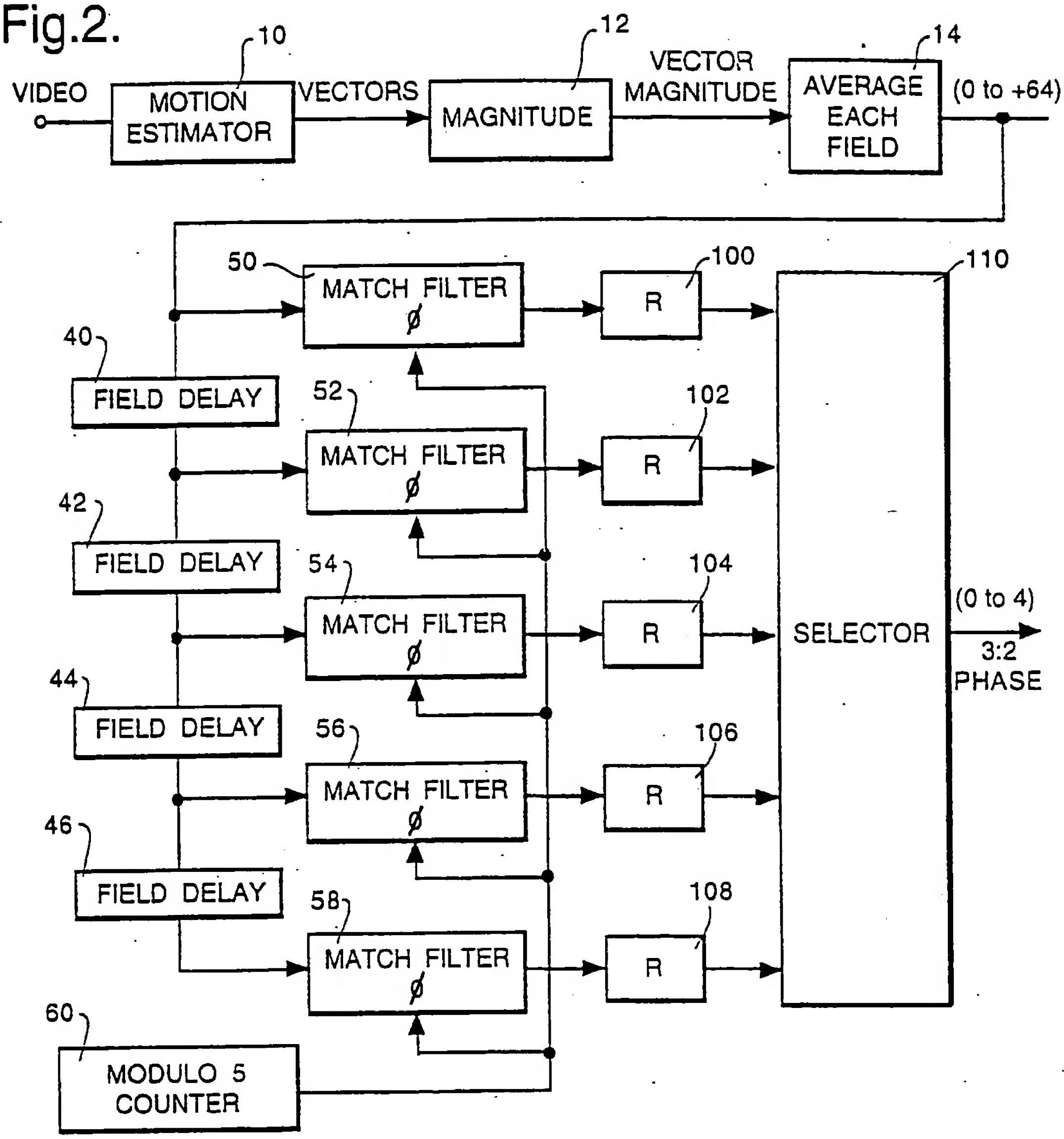
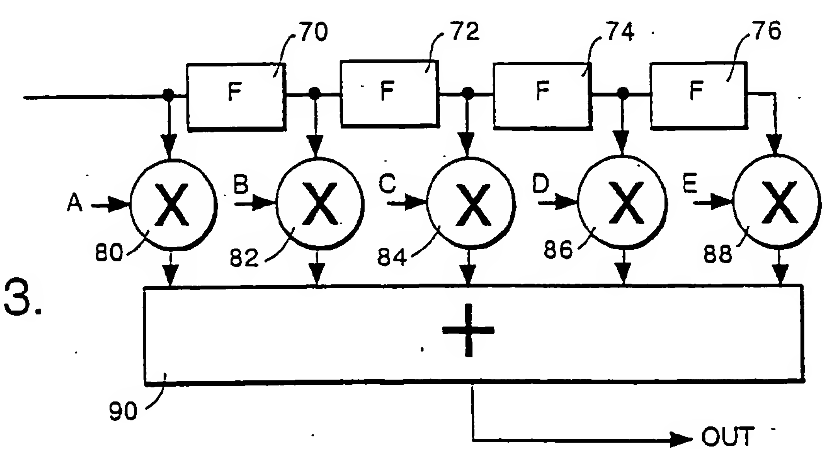

VIDEO
MOTION ESTIMATOR
10
VECTORS
MAGNITUDE
12
VECTORS MAGNITUDE
CALCULATE AVERAGE EACH FIELD
14
FIELD DELAY
18
NEW
OLD
(0 to 64)
SUBTRACT
16
MAGNITUDE
20
(-64 to 64)
(0 to 64)
SUBTRACT
22
(-64 to +64)
x16
24
SENSITIVITY CONTROL
+ve AND -ve CLIP
26
(CLIPLIMIT = ± 5)
RATE OF CHANGE OF FORMAT CONTROL
(-5 to +5)
28
+ve AND -ve CLIP
30
(CLIPLIMIT = ± 25)
FIELD DELAY
32
INPUT FORMAT
+ 25 => VIDEO ORIGINATED MATERIAL
- 25 => FILM ORIGINATED MATERIAL
φ => DON'T KNOW

Fig.2.



VIDEO
MOTION ESTIMATOR
10
VECTORS
MAGNITUDE
12
VECTOR MAGNITUDE
AVERAGE EACH FIELD
14
(0 to +64)
50
MATCH FILTER ø
100
R
110
40
FIELD DELAY
52
MATCH FILTER ø
102
R
42
FIELD DELAY
54
MATCH FILTER ø
104
R
SELECTOR
(0 to 4)
3:2 PHASE
44
FIELD DELAY
56
MATCH FILTER ø
106
R
46
FIELD DELAY
58
MATCH FILTER ø
108
R
60
MODULO 5 COUNTER



70
72
74
76
F
F
F
F
A
B
C
D
E
X
X
X
X
X
80
82
84
86
88
+
90
OUT

Fig.3.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 95/00478

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N7/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 982 280 (LYON ET AL.) 1 January 1991 see the whole document ---	1,4
A	GB,A,2 240 232 (AVESCO PIC) 24 July 1991 see page 37, line 1 - page 40, line 4; figures 7,8 ---	1,4
A	EP,A,0 576 080 (PHILIPS ELECTRONICS N.V.) 29 December 1993 see column 2, line 41 - column 4, line 18; figure 1 -----	1,4

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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2

Date of the actual completion of the international search	Date of mailing of the international search report
17 May 1995	31. 07. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	VERLEYE, J

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB95/00478

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. claims 1-6: method and apparatus for detecting the residual effect of a past conversion from a lower temporal sampling rate
2. claims 7-10: method and apparatus for identifying the phase of the field duplicating and reordering sequence in video signals

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-6

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 95/00478

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4982280	01-01-91	JP-A-	3058677	13-03-91
GB-A-2240232	24-07-91	US-A-	5221966	22-06-93
EP-A-0576080	29-12-93	JP-A-	6098256	08-04-94
		US-A-	5365280	15-11-94